



Department of
Biomedical Engineering
UNIVERSITY OF WISCONSIN-MADISON

Low-Interference Wheelchair Footrest

10/6/2023

Advisor: Prof. William Murphy

Client: Mr. Dan Dorszynski

The Team

Lael Warren: Team Leader
Liv Baumann: Team Leader/ BSAC
Amanda Kothe: Communicator
Juliana Dugo: BPAG
Sadie Rowe: BWIG
Gracie Hastreiter: BWIG



Team Members (left to right): Liv Baumann, Lael Warren, Gracie Hastreiter, Sadie Rowe, Juliana Dugo, Amanda Kothe

Figure 1: Team Photo

Problem Statement & Client Information

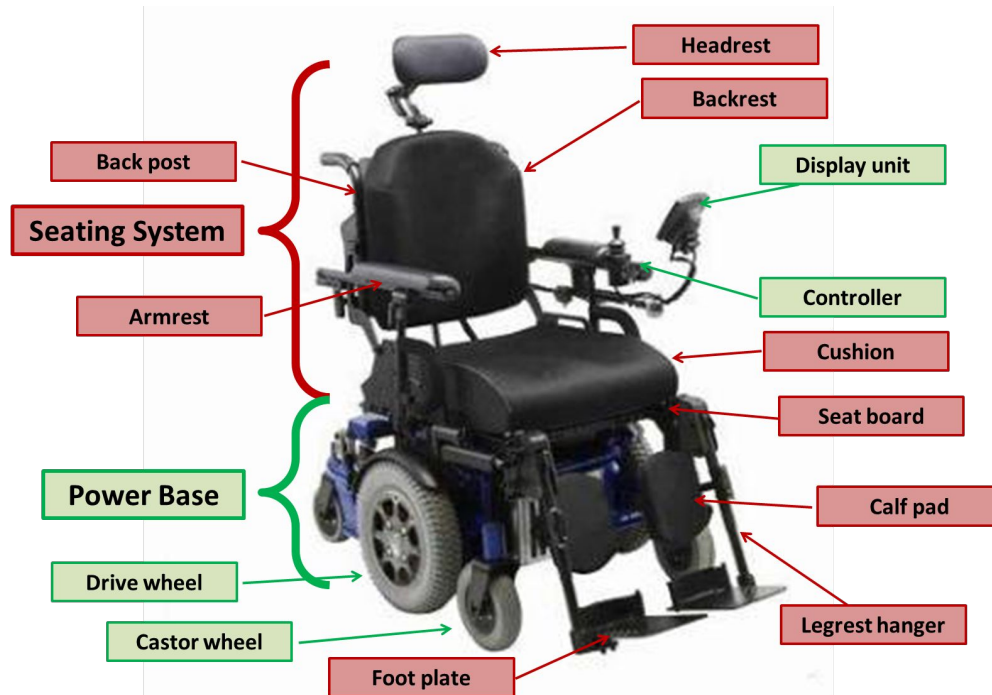
- There are currently no wheelchairs on the market which allows those who are not paralyzed to perform helpful movements
- Current footrest models are heavy, bulky, and not easily able to be removed and stored when not in use.
- Updated footrests should be able to adapt to a person's abilities, should be easily able to remove and store them when not in use, and be lighter and less bulky.

Client: Mr. Dan Dorszynski



Figure 2: Quickie Q700 M
Wheelchair [1]

Background



Main issues:

- Bulky footrests and calf pads interfere with daily activity
- Footrests have a large radius when they swing outwards
- Difficult Removal
- Heavy
- No place to store the footrests when you take them off

Figure 3: Components of a Mechanical Wheelchair [2]

Competing Designs



Drive Medical Swing-Away Footrests

- Notable features:
 - Heel strap
 - Swing-away foot pedal

Figure 4: Drive Medical Swing Away Footrests [3]



Invacare Leg Rests

- Notable feature:
 - Padded Calf Support

Figure 6: Invacare Hemi Elevating Leg Rests [4]

Standard Footplate

- Notable feature:
 - 90° with footrest hanger



Figure 5: Motion Composites Standard Carbon Fiber Footplate [5]

Rigid Footplate

- Notable feature:
 - Large platform for both feet



Figure 7: Motion Composites Rigid Wheelchair Footplate [5]

Summary of PDS

Client Requirements:

1. Combined weight between 3-4 lbs
2. Easily stored or removable
3. Does not restrict leg movement
4. Heel Support

Design Requirements:

1. Life in service 4-5 years
2. Constructed of a durable, long-lasting material
3. Supports the force of clients feet
4. Securely attaches to wheelchair base

PDS

Fold-Up Footrest

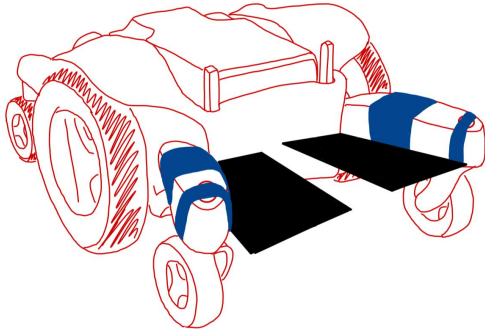


Figure 8: Footrest Laying Flat

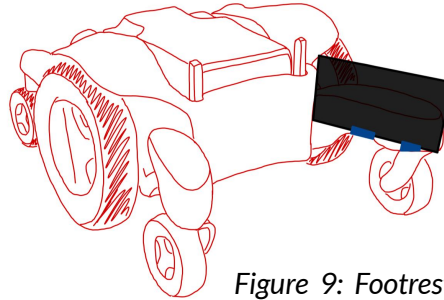


Figure 9: Footrest in storage position

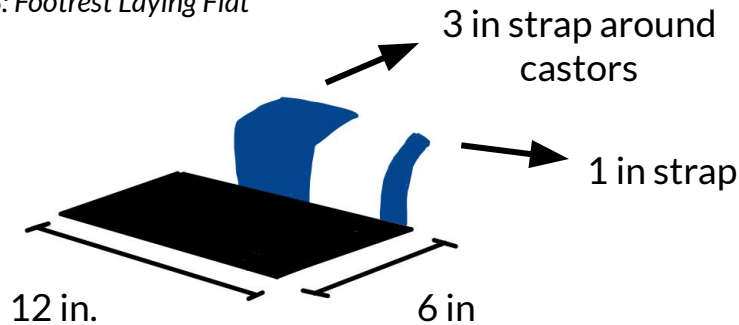


Figure 10: Footrest Component

Advantages:

- Storage
- Weight
- Ease of Use

Disadvantages:

- Client reaching footrest
- Cost

Folding Mesh Footrest

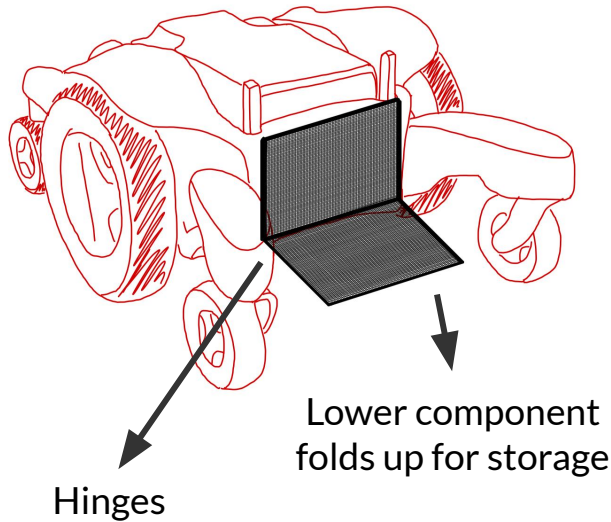


Figure 11: Folding Mesh Footrest
Design Drawing on wheelchair base

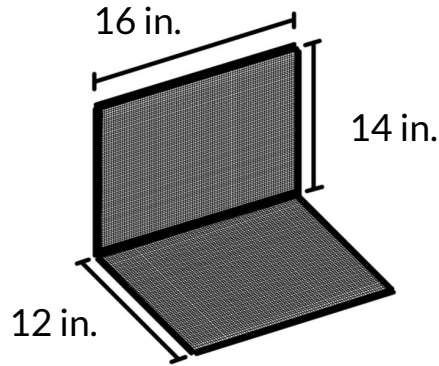


Figure 12: Folding Mesh Footrest
Design Drawing

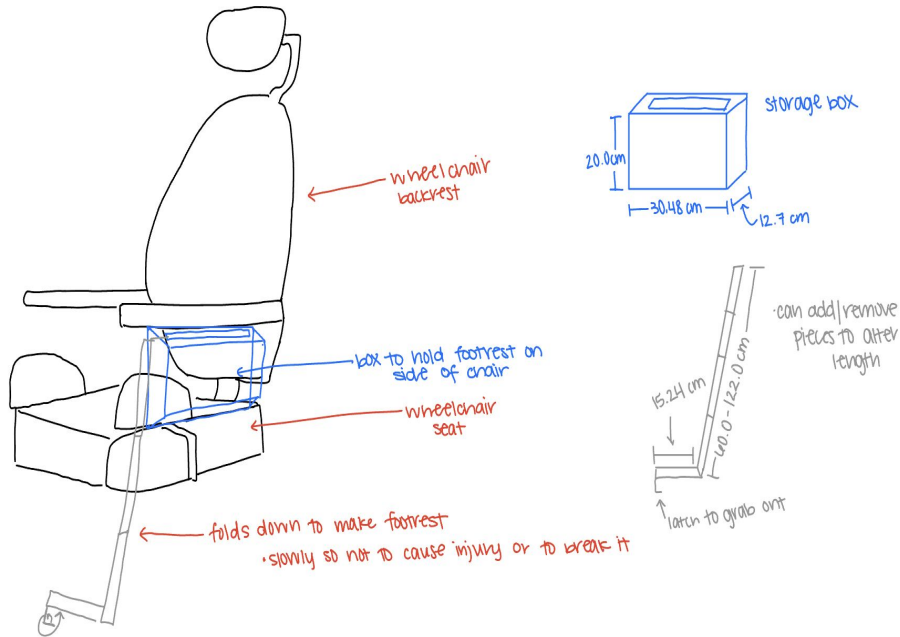
Advantages:

- Not bulky
- Storage on wheelchair
- Removable
- Attaches to wheelchair base

Disadvantages:

- Durability
- Difficult to fold up

Airplane Armrest



Advantages:

- Storage
- Moves with wheelchair seat

Disadvantages:

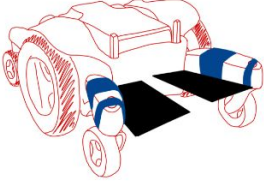
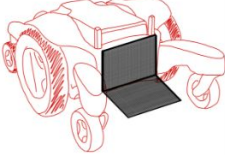
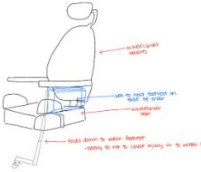
- Not attached to wheelchair base
- Requires some force to move into proper positions
- Box to store in bulky

Figure 13: Airplane Armrest
Design Drawing

Design Matrix Criteria

Criteria	Weight	Description
Ease of Use	25	How easy it is to set the footrests up to be used
Storage	20	How easily can the footrests be stored on the wheelchair
Weight	15	Is the weight less than 4 pounds
Size	15	Is the footrest small enough to fit in the wheelchair, do the client's feet fit on the footrest
Ease of Fabrication	10	How easy are the footrests to fabricate
Durability	10	Is the material able to withstand the elements and day-to-day wear and tear
Cost	5	How much does it cost to fabricate

Design Matrix

	Design 1: Fold-Up Footrest 	Design 2: Folding Mesh Footrest 	Design 3: Airplane Armrest 
Ease of use (25)	5/5	5/5	2/5
Storage (20)	5/5	4/5	3/5
Weight (15)	4/5	5/5	2/5
Size (15)	5/5	5/5	3/5
Ease of Fabrication (10)	4/5	5/5	1/5
Durability (10)	5/5	3/5	3/5
Cost (5)	3/5	5/5	2/5
Total (100)	93	92	47

Chosen Preliminary Design



Figure 16: Chosen Preliminary Design-
Fold-Up Footrest

Chosen Preliminary Design

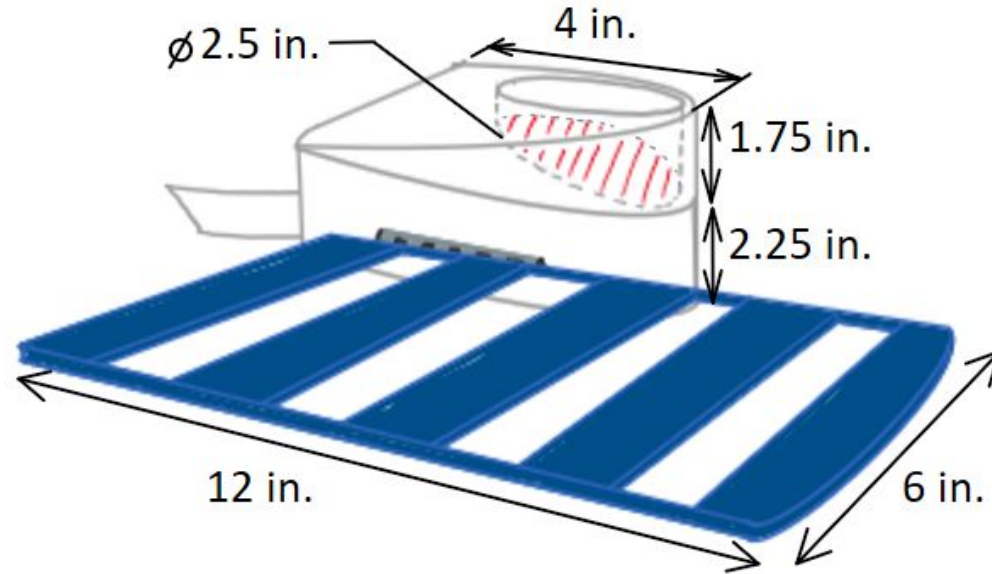


Figure 17: Dimensioned Design

Future Work

This semester:

- Decide materials
- Plan manufacturing processes
- Outline testing procedures

Beyond this semester:

- Incorporating wheelchair tilt
- Electronic components

Acknowledgements

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- Mr. Dan Dorszynski
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- BME Department

References

- [1] “Quickie Q700 M power wheelchair,” Sunrise Medical, <https://www.sunrisemedical.com/power-wheelchairs/quickie/mid-wheel-drive/q700-m> (accessed Sep. 21, 2023).
- [2] A. for C. Innovation, “Spinal Seating Modules,” State Spinal Cord Injury Service | Agency for Clinical Innovation, <https://aci.health.nsw.gov.au/networks/spinal-cord-injury/spinal-seating/module-10/keep-the-big-picture-in-mind> (accessed Sep. 20, 2023).
- [3] “Drive Medical Swing Away Footrests,” Vitality Medical. <https://www.vitalitymedical.com/wheelchair-swing-away-footrests-stds3j24sf.html> (accessed Sep. 20, 2023).
- [4] “Invacare Footrest Assembly,” Quickie Wheelchairs. <https://www.quickie-wheelchairs.com/Wheelchair-Parts-Accessories/Assorted-Wheelchair-Parts/Footrests-Legrests/Invacare-Footrest-Assembly-3-1-8-Pin-Spacing-Pair/24518p> (accessed Sep. 20, 2023).
- [5] “Footrest options to support function and mobility,” Tips and advice, Motion Composites, https://www.motioncomposites.com/en_us/community/blog/tips-and-tricks/footrest-options-to-support-function-and-mobility (accessed Sep. 20, 2023).

Questions?